INSTRUCTION MANUAL

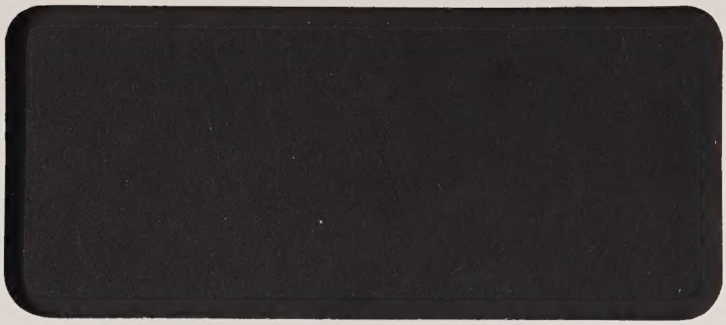
MODEL 400 SERIES*

RELATIVE HUMIDITY AND TEMPERATURE INDICATOR

MASTER COPY

MS 22 (3-87)

GENERAL EASTERN



INSTRUCTION MANUAL

MODEL 400 SERIES*

RELATIVE HUMIDITY AND TEMPERATURE INDICATOR

*Includes Models 400C, 400CD
402, 450

June 1975

CERTIFICATION OF CALIBRATION

This instrument has been calibrated at 33%RH and 96.5%RH, to within ±0.5%, in accordance with ASTM Recommended Practice E104-51.

Serial No. 52973

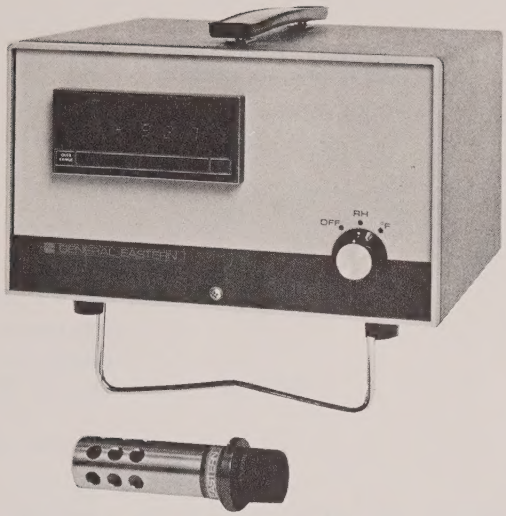
Date _____

By: _____

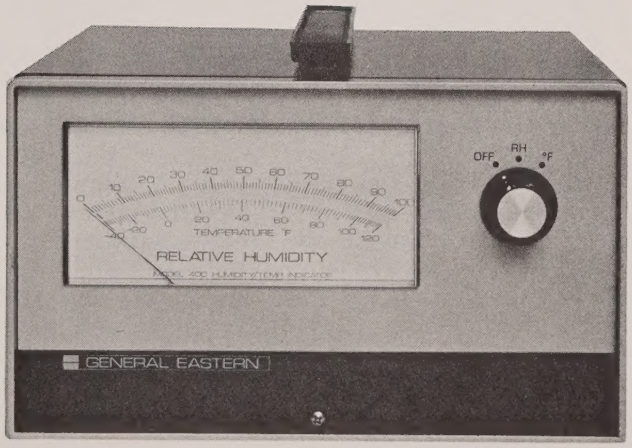
General Eastern Corporation
36 Maple Street
Watertown, Massachusetts 02172
TEL: 617-923-2386

Digitized by the Internet Archive
in 2025

https://archive.org/details/manualsplus_05581



MODEL 400CD (DIGITAL) RELATIVE HUMIDITY AND TEMPERATURE INDICATOR



MODEL 400C (ANALOG) RELATIVE HUMIDITY AND TEMPERATURE INDICATOR

TABLE OF CONTENTS

		PAGE
PREFACE		i
1.0	DESCRIPTION	1
	1.1 Specifications	1
	1.2 Types of Gases	1
	1.3 Care of the Humidity Sensor	1
2.0	PRINCIPLE OF OPERATION	3
	2.1 Sensor Characteristics	3
	2.1.1 Effects of Contaminants and Aging	3
	2.1.2 Sensor Response Time	3
	2.1.3 Hysteresis Characteristics	3
	2.2 Block Diagram Description	4
3.0	INSTALLATION PROCEDURES	5
	3.1 Sensor Installation Requirements	5
	3.2 Pressure Vacuum Installations	5
	3.3 Indicator Installation	6
	3.4 Sensor Cabling Requirements	6
	3.5 Recorder Selection and Connections	6
4.0	OPERATING PROCEDURES/INTERPRETATION OF DATA	8
	4.1 Interpreting Readings	8
5.0	MAINTENANCE AND TROUBLESHOOTING	9
	5.1 Recalibration Procedures	9
	5.2 Compensation Adjustments for Changes in the RH Sensor	9
	5.2.1 Establishing Known %RH Environments	9
	5.2.2 Adjustments - Detailed Procedure	10
	5.2.3 Changing Humidity Elements	11
	5.3 Meter Face Care	11
	5.4 Troubleshooting	12
	5.4.1 Low or No Readings	12
	5.4.2 Offscale (Above 100% RH or +150F) Readings	12
	5.4.3 Erratic Readings	12
6.0	APPENDIX	13

IMPORTANT - READ

PREFACE

The measurement of humidity is necessary in many scientific and manufacturing activities. Humidity, or water vapor content of the air, can be expressed in a number of forms, including absolute humidity, mixing ratio, dew point and relative humidity. A widely used method of expression is percent Relative Humidity. This is unfortunate in many respects, as the measurement of relative humidity is often a difficult one, resulting in poor accuracy of the humidity measurement, when made directly. On the other hand, for many applications it is the only meaningful measurement to make. Accurate measurements of Relative Humidity can be made if the user will pay attention to the guidelines presented in this Manual.

Relative Humidity is defined as the ratio of the water vapor pressure in a given sample of air, to the water vapor pressure the same air could hold if it were fully saturated with water vapor at the same temperature, expressed as a percentage.

A variety of instruments have been designed over the years to measure %RH. One group of instruments uses material such as animal membranes, hair elements, wood and synthetic fibres as sensing devices. These materials undergo changes in physical properties, usually length, as the amount of water vapor in the air changes. Instruments of this type are widely used for monitoring purposes where fast response, accuracy and small sensor size are not paramount requirements. Another group of instruments utilizes wet and dry bulb thermometers, and the RH is determined from the wet and dry bulb readings and a psychrometric table. This is known as the psychrometric method and can provide accurate data for relative humidities above about 20%, when properly used. When improperly employed, psychrometers can give gross errors.

Many scientific and industrial measurements require a relative humidity sensor which is small in size, fast in response, wide in range and capable of an electrical output which can be transmitted to a remote reading or recording point. These electrical humidity sensors generally employ a hygroscopic chemical (such as lithium chloride) or an ion-exchange resin (such as sulphonated polystyrene) the resistance of which is monitored by use of a conductive grid system and an alternating current electrical bridge. Alternating current is required in the bridge circuit to prevent polarization of the sensor. The General Eastern Model 411 Relative Humidity and Temperature Sensor utilizes the ion-exchange humidity element for the reason that a single humidity element can cover the entire range of relative humidity.

All resistance-type electrical humidity sensors exhibit a highly non-linear change in resistance as a function of RH. Linearization by electronic means is desirable, in order to permit a readable presentation of RH on a meter scale or recorder; otherwise the display is highly compressed at one end of the scale. All electrical humidity sensors also exhibit a temperature dependence, and it is common practice to employ an independent temperature

sensor to correct this effect. The temperature effect is small in the case of the sulfonated polystyrene sensor and a thermistor is used in the Model 411 for compensation. A completely separate temperature sensor (a linear platinum RTD in the 411) is used to monitor the ambient temperature of the sample.

The Model 400C Relative Humidity and Temperature Indicator represents the state of the art in this class of humidity instrumentation. Only the finest components have been employed in its manufacture. When used in accordance with the guidelines set forth in this Manual, it is capable of giving the highest accuracy attainable with an electrical humidity sensor.

1.0 DESCRIPTION

The Model 400C is designed for making measurements of RELATIVE HUMIDITY AND TEMPERATURE in non-corrosive gas atmospheres. The instrument employs a time-proven sulfonated polystyrene ion exchange humidity sensor which produces large changes in electrical resistance with changes in relative humidity. Temperature-induced humidity changes are eliminated by means of an integrally mounted compensating thermistor. A separate platinum thermometer is used for making measurements of temperature of the sample. The instrument produces linear displays and linear output signals for the entire Relative Humidity range of 0-100%RH, and the temperature range of -50F (-46°C) to +150F (+66°C) with a single sensor.

The RH and Temperature sensors are mounted in a rugged, anodized-aluminum collar with environmentally rated MS-type connectors. The sensors are protected with a stainless steel cover, and may be used as hand-held devices, or in a pressure or vacuum mount. Sensors are furnished with a ten foot length of neo-prene jacketed shielded cable, complete with MS-type mating connectors. The humidity element can be easily replaced or recalibrated without requiring replacement of the entire sensor assembly.

1.1 Specifications

RELATIVE HUMIDITY

Meter Range: 0-100%RH, linear display
Accuracy: between 15% and 95%RH, ±3%
Temperature Span for RH: 0 to 140F (-18°C to +60°C) Max Temp: 200F (93C)
Readability and Resolution: 0.5%
Response: 30 seconds or less for a 63% change in RH, in air at 1 fps (30 cm/sec)

TEMPERATURE

Range: -50F to +150F (-46°C to +66°C)
Accuracy: ±2F (±1°C)
Readability: 0.5F (0.25°C)

PRESSURE RATING: Vacuum to 200 psig (14 kg/cm^2)

RECORDER OUTPUT: (Analog) Simultaneous 0-50 mvdc and 0-5 vdc linear @100 ohms output impedance, for both %RH and Temperature.
(Digital) Simultaneous -12.5 mvdc to 37.5 mvdc; 1.25 vdc to 3.75 vdc for temperature output only. Maximum recommended loading 10K ohm.)

POWER REQUIREMENTS: 105/125 VAC, 50/440 Hz, 3 watts

1.2 Types of Gases

The sensor is intended for use in non-corrosive gas atmospheres such as air, nitrogen, carbon dioxide, oxygen, hydrogen, etc. Use of the humidity sensor in corrosive gases such as SO_2, chlorine, HCl, etc., will permanently damage the sensor.

1.3 Care of the Humidity Sensor

The ion-exchange RH sensor will provide many years of reliable operation if certain precautions are taken:

a) Avoid touching the sensor surface with the fingers; the normal body acids and oils are sufficient to permanently shift the calibration curve.

b) Do not blow smoke on the sensor.

c) Do not attempt to wash the sensor with water or solvents. If the surface of the sensor becomes dust laden, this generally does not affect calibration, but does reduce the sensor response slightly. The dust can be removed by brushing gently with a clean, soft, camel's hair brush.

d) The sensor operates on an ion-exchange basis; any environment which attacks polystyrene will eventually shift the calibration.

e) Maximum RH sensor temperature is 200F.(93°C) Exposure to temperatures above 200F (93°C) will permanently damage the sensor.

2.0 PRINCIPLE OF OPERATION

2.1 Sensor Characteristics

The Model 400C employs a sulfonated polystyrene, ion-exchange humidity sensitive element (also known as a Pope cell, after its inventor) for measuring percent relative humidity. The sensor is made by chemically attaching sulfate ions to the long chain polystyrene molecule - a process called sulfonation - which results in an electrically-conducting, water vapor sensitive, surface deposited over an insulative substrate. As the active sulfate ions take on or give up water vapor by surface adsorption as a function of relative humidity, the surface resistivity changes. The sensor has an impedance of approximately 1000 ohms at 100%RH, increasing to 5-10 megohms at 10%RH. The surface resistivity is measured by an AC bridge circuit monitoring a bililar conductive grid on the surface of the humidity element. The humidity element is slightly temperature sensitive, hence a thermistor is employed as an integral part of the Model 411 RH and Temperature Sensor to compensate this effect.

2.1.1 Effects of Contaminants and Aging

The humidity elements are manufactured to close tolerance, and when new are essentially interchangeable. At the time of manufacture, each instrument and sensor is calibrated against an NBS-calibrated, optical dew point hygrometer at several points. However, all electric or resistance-type humidity sensors are subject to slight changes in their RH vs resistance characteristics with time; so-called aging. The degree of shift with time depends primarily on the type and amount of contamination the humidity element has been subjected to during its period of usage. In a clean environment, a typical humidity element will not shift more than 1-2% RH in a year's time. All General Eastern instruments are provided with simple-to-adjust calibration controls to compensate for shift in sensor characteristics. It is seldom necessary to replace the humidity element.

2.1.2 Sensor Response Time

The response time of the sensor is shorter for increasing than for decreasing RH excursions due to the fact that water is adsorbed rapidly, but released relatively slowly. Adequate ventilation improves the response time. For a condition of one ft/sec (30 cm/sec) the transducer has a response time of 30 seconds or better for a 63% change in RH.

2.1.3 Hysteresis Characteristics

Hysteresis, exhibited by all RH sensors, is linked, in part, to the mechanism of adsorption and diffusion. As RH is varied from one extreme to the other and back, the sensor will describe a hysteresis loop that is widest in the 50% range (approximately $\pm 2\frac{1}{2}$% RH). In the vast majority of applications, hysteresis may be neglected; however, when the highest accuracy is desired, it is important to be mindful of the direction of the RH change.

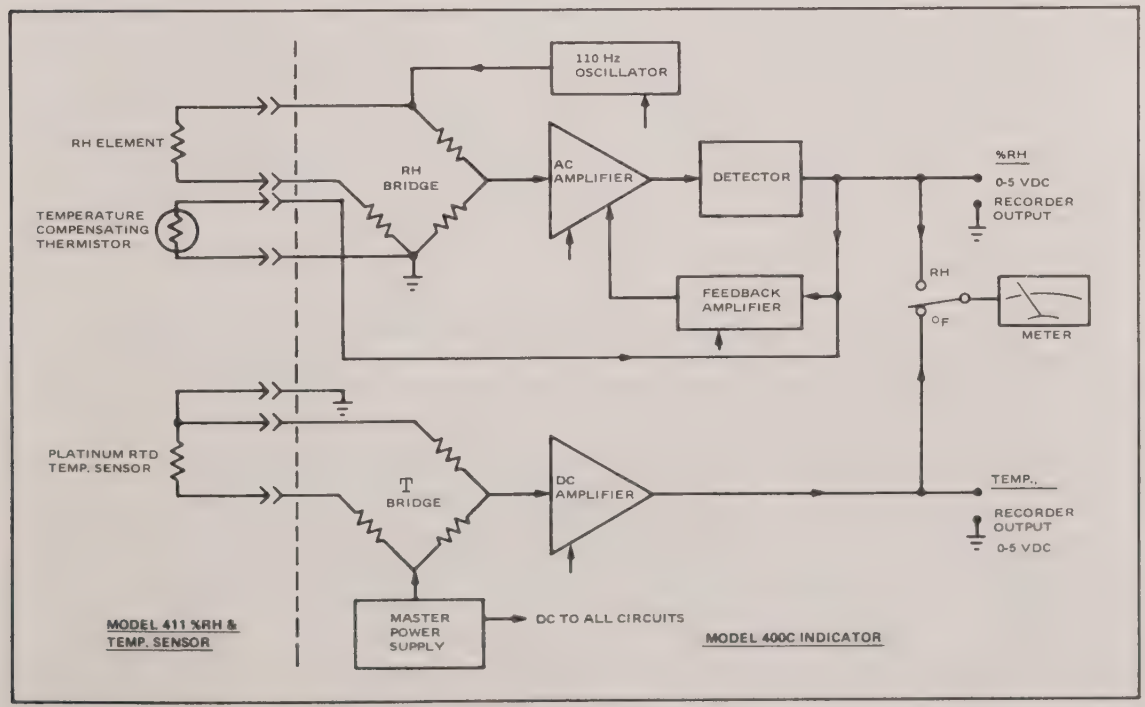
2.2 Block Diagram Description

The Model 400C is powered by a solid state, regulated, power supply which provides ±15 VDC. The total power consumption is about 3 watts.

A single op-amp is used as an oscillator to provide a 110 Hz square wave to excite the sulfonated polystyrene sensor and to avoid polarization. A ten-to-one change in RH (from 10% to 100%) results in a change in sensor resistance of about 9000 to 1, and therefore a non-linear compensating circuit is required to provide a linear RH readout. Such a circuit is accomplished through the use of matched semiconductor diode characteristics in the amplifier and feedback circuits. The circuit arrangement permits adjustments at 0% RH, 100% RH, and 30% RH for best linearity. The slight sensor temperature sensitivity is compensated by means of a sensor-mounted thermistor, fed to the feedback circuit. Integrated circuit amplifiers are used exclusively, providing the advantages of low power consumption and zero warmup time.

The ambient temperature measurement is accomplished through the use of a platinum RTD at the sensor. The three-wire bridge is passive and utilizes low thermal coefficient precision resistors. The bridge output is amplified to a 5 volt level for output and metering.

The complete schematic for the instrument will be found in the Appendix to this Manual.



FUNCTIONAL BLOCK DIAGRAM

3.0 INSTALLATION PROCEDURES

3.1 Sensor Installation Requirements

The Model 411 RH and Temperature Sensor is designed to permit a variety of installation configurations. The most often used configuration is to simply employ the sensor as a hand-held probe - a procedure that can lead to erroneous data, since the hand itself is a source of moisture, and can cause higher-than-actual readings. When using the sensor as a hand-held device, grip the unit by the rear of the connector, and hold the sensor into the direction of the air flow. Do not shield the sensor with the body. Allow the sensor sufficient time - at least 90 seconds - to equilibrate with the sample. At low air flow, or in stagnant air measurements, several minutes must be allowed to obtain meaningful measurements.

The Model 411 Sensor can also be permanently installed in a simple wall or ceiling bracket. In selecting a location for the sensor, consideration must be given to obtaining a location which is representative of the room or duct to be measured. The following guidelines are offered:

a) A sensor location directly in front of a high flow duct should be avoided to minimize the accumulation of dust on the sensor.

b) A flow rate of 1 fps[1] (not critical) is adequate to insure good response - fast flow rates only serve to increase the contamination rate of the sensor.

c) Moist air is lighter than dry air and therefore rises. Rooms with poor ventilation exhibit higher humidities at the ceiling than near the floor - often significant differences can occur when temperature gradients are not large.

d) Select a location which is out of reach of inquisitive fingers, smoke and other contaminants.

e) Where high flow rates or heavy dust levels prevail, locate the sensor under a suitable shield.

f) When the probe is placed in an environment with a large temperature change, additional time may be required prior to reading to allow for temperature equilibration of the sensor.

3.2 Pressure/Vacuum Installations

The Model 411 RH and Temperature Sensor can be used to monitor non-corrosive gases in pressurized or vacuum lines by using the Type 011 Mounting Boss. This Boss is equipped with an O-ring collar to insure leak-proof installation, and ease of sensor maintenance. Refer to the Type 011 Installation Drawing in the Appendix for installation details.

[1] 30 cm/sec

3.3 Indicator Installation

The indicator may be located on a bench or shelf, or may be panel-mounted. For bench mounting, a flip foot is provided for ease of reading.

For panel mounting, a 4.75 x 9.75 inch hole is cut in the panel. The panel should not exceed 1/4 inch in thickness. Six, 3/16 inch diameter holes are drilled in accordance with the installation drawing.*

a) Remove the instrument from its case by releasing the two retaining screws in the rear deck of the instrument case, and the single retaining screw in the front panel.

b) Mount the case by means of four, 6-32 x 5/8 screws in the four corner holes of the case lip. Do not install screws in the center top and center bottom holes - these are clearance holes for front panel alignment screws.

c) Slide the panel chassis assembly into the case and secure in place with the single no. 6-32 machine screw in the front panel. Rear deck screws need not be replaced for panel mounting, and must not be replaced if front panel access is desired for servicing. Be sure to allow sufficient slack in cabling to permit removing the instrument from the front.

3.4 Sensor Cabling Requirements

The Model 411 RH and Temperature Sensor is connected to the bulkhead MS-connector at the rear of the instrument, using the 10-foot neoprene-jacketed cable provided. It is permissable to extend the sensor cable up to 250 feet, using Belden-type 8426 shielded cable or equivalent. For longer cable lengths, consult factory. General Eastern can furnish extension cables in multiples of 20 feet, complete with terminations.

3.5 Recorder Selection and Connections

The Model 400C is provided with independent and continuous recorder outputs for the %RH and Temperature variables. These output signals, available at the rear terminal barrier strip, are present at all times, and are independent of the position of the front panel function switch. The recorder output signals are in the form of low impedance (under 100 ohms) 0-5 VDC linear signals, with a tap in the resistance output divider to also provide a 0-50 MVDC output signal. Both %RH and temperature outputs are linear, and correlate directly with the front panel meter display. The outputs are as follows:

%RH Output - All Models except Model 450
0 VDC @ 0 %RH; 50 mVDC and 5.00 VDC @ 100% RH

Temperature

a) Model 400C
0 VDC @ -50°F (45.6°C); 50 mVDC and 5.00 VDC @150°F (66°C)

b) Model 400CD with Temperature in °F
0 VDC @ 0°F; +25 mVDC and 2.5 VDC @100°F, -12.5 mVDC and -1.25 VDC @ -50°F.

* See rear of Specification Sheet

c) Model 400CD with Temperature in °C
0 VDC @ 0°C; 25 mVDC and 2.5 VDC @50°C; -25 mVDC and -2.5 VDC @-50°C

Model 450 has 0-5 VDC output only for both %RH and Temperature.

Recorder Selection: The 0-50 MVDC output is best suited to operating conventional servo-type recording systems having full scale sensitivities of 50 MVDC of better. The 0-5 VDC outputs are also capable of operating servo recorders, but can also drive galvanometer recorders or industrial control devices. For operating the popular 0-1 mADC "meter movement" recorders a 5000 ohm potentiometer in series with a 2.7K fixed resistor provides a convenient means for calibrating the recorder to the instrument 5 VDC output.

4.0 OPERATING PROCEDURES/INTERPRETATION OF DATA

This instrument is of solid-state design and is ready for operation without warmup. Percent Relative Humidity is displayed on the upper scale of the meter when the function switch is in the RH position. The temperature of the sample can be read on the lower meter scale when the function switch is in the TEMP position. Recorder output voltages are present at all times, independent of the meter switch position.

4.1 Interpreting Readings

As discussed in the preface to this manual, accurate measurements of relative humidity are very difficult to make. The reason for this is inherent in the definition of the parameter - RH is a function of both temperature and vapor pressure, and the effects of hysteresis, linearity, response time, (which are common to any data transducer) are doubly imposed on an RH transducer, regardless of type. The best assurance of accurate data is to make every effort to minimize these effects when making a measurement.

For applications where %RH and temperature can only change at a slow rate - over a period of hours - and where good mixing of the sample and adequate flow exists, RH measurements can be made with an accuracy of 1-2% RH.

For applications where the humidity is constantly changing, or where there are considerable gradients of either temperature or RH, the effects of the ever-present hysteresis (about 2% for short time intervals), and for response time, must be reckoned with. For example, measurements made in small stagnant enclosures - animal cages, incubators, dry or semi-moist food products, paper stacks, etc., should be given adequate time for the sensor to equilibrate with the environment. The best procedure to follow is to record the data until a stable and credible value is achieved.

From an accurate measurement of RH and temperature, most of the other popular humidity parameters can be obtained by use of the psychrometric chart.

5.0 MAINTENANCE AND TROUBLESHOOTING

5.1 Recalibration Procedures

The instrument calibration can be checked by substituting a known resistance in place of the RH or temperature sensor. This procedure, which involves the adjustment of internal controls, is given in the Appendix "Factory Checkout Procedure" and should not be attempted by other than a qualified technician with the necessary test equipment. The overall accuracy of the sensor plus instrument can be checked by placing the sensor in a known humidity or temperature environment.

NOTE: Before attempting to calibrate the instrument, turn the instrument power off and check that the mechanical zero of the meter is at zero. If it is not, it can be set to zero with the adjusting screw on the inside rear surface of the meter hub.

5.2 Compensation Adjustments for Changes in the RH Sensor

At the time of manufacture, the Model 400C is calibrated against a known humidity (measured with an NBS-traceable instrument) at several different values of RH. After prolonged usage, the calibration of the RH sensor should be checked for any changes caused by contamination or aging of the sensor substrate. The Model 400C is provided with simple external adjustments on the rear of the instrument, which allow most changes in the sensor charactertistics to be readily compensated. See Factory Test Procedure, Appendix.

5.2.1 Establishing Known %RH Environments

To perform these adjustments, two known RH environments are required, one near 90% RH (±9%), and a second near 30% RH (±5%). A variety of methods have been developed by the National Bureau of Standards[1] and are widely endorsed by ASTM[2] for establishing known humidities. Of the various methods available, those employing closed containers of saturated salt solutions have proven to work well in calibrating the Model 400C. In using saturated salt solutions care must be taken so as not to contaminate the sensor surface with the salt. A saturated mixture of reagent grade potassium sulphate (K_2SO_4) can be used to establish 96.5% RH, and a saturated salt solution of reagent grade magnesium chloride ($MgCl_2$) will produce 33% RH. When preparing saturated salt solutions, add only sufficient distilled water to produce a heavy slush of the water-salt mixture. Undissolved crystals of the salt must be visible in the mixture.

The saturated salt solutions may be contained in any suitable laboratory glassware which can be fitted to the sensor to result in an airtight seal. The protective stainless steel sleeve can be removed from the sensor to expedite equilibrating the humidity element with the new RH, and the O-ring can be used to effect a good seal. Details for a suitable fixture fashioned from a common canning jar are given in the Appendix. The salt solutions are selected to have minimum temperature/RH coefficients. However, to minimize temperature-induced errors, all calibrations should be made in a temperature-controlled room at approximately 77°F (25°C).

---

1. Wexler, A. "Humidity and Moisture", Vol. III, Reinhold Publishing, New York, 1964.
2. See ASTM Recommended Practice E104-51.

Temperature gradients in the container must be minimized. For example, if a solution at 79°F produces an RH of 96.5% at the surface, a temperature of 80°F at the top of the container will result in an RH of 93.4% at the top (26°C and 26.7°C, respectively).

- - - - - WARNING - - - - -

Users of relative humidity instruments are tempted to compare readings of the RH instrument with humidity readings taken with wet/dry bulb psychrometers, which they may have used as a "standard" with confidence for many years. Considerable difference between the RH instrument and the psychrometer readings are often witnessed, not as a result of shortcomings of either instrument, but as a result of the way the particular instruments are used, or because of the considerable expertise required to properly use a psychrometer. The psychrometer can produce relative humidity readings twice as high as those obtained with the Model 400C, particularly at low values of RH. This discrepancy can usually be traced to one or more of the following misuses of the psychrometer:

a) Insufficient air flow or insufficient time to cause complete depression of the wet bulb, resulting in a higher than actual reading.

b) Dirty, oily, or poorly wetted wick, resulting in a higher than actual reading.

c) Poorly fitted wick to the wet bulb, failing to provide uniform wetting of the bulb, resulting in a higher than actual reading.

d) Failure to read the wet bulb temperature at the point of maximum depression, resulting in a higher than actual reading.

e) The presence of the psychrometer in a small sampling volume can increase the humidity of that volume.

The above factors tend to make the typical psychrometer ill-suited for calibration work, except when a precision-grade psychrometer (such as the Assman type) is employed in the hands of a skilled technician.

5.2.2 Adjustments - Detailed Procedure

To recalibrate the humidity sensor, first check the mechanical zero of the meter, adjusting it if necessary, and then energize the instrument and proceed as follows:

a) Place the RH probe in an environment of approximately 50% for at least 90 minutes before starting to recalibrate. This step helps to minimize hysteresis in the calibration process. (Approximately 53% RH can be established with a saturated solution of magnesium nitrate.)

b) Place the RH probe in a known environment between 90 and 99% RH, and at an ambient temperature of 77F, ±5°F.* (The sensor housing must not be below the ambient temperature of test environment

*25°C ±0.25°C

to prevent condensation from forming on the sensor). The actual %RH selected is not critical, but its exact value should be known at least to within ±1% RH. Allow at least 90 minutes for the sensor to fully equilibrate with the known environment. If the known environment is flowing, the sensor will come to equilibrium much faster.

c) Adjust the "100% RH CAL" control on the rear panel to provide the correct front panel meter reading.

d) Place the RH sensor in an environment below 30% RH: a salt bath of potassium acetate (CH_3 COOK) may be used to establish 20% RH. Wait sufficient time for sensor to "dry down". Do not adjust.

e) Place the RH sensor in a known environment of approximately 30% RH, again allowing at least 90 minutes for the sensor to equilibrate with the sample. A salt bath of magnesium chloride (MgCl) may be used to establish 33%RH.

f) Adjust the "30% RH CAL" control on the rear panel to provide the correct front panel meter reading.

g) Lock both controls.

h) Both points may be rechecked and the procedure repeated, if desired.

i) A mid-point on the curve may be checked by placing the sensor in a bath of magnesium nitrate ($MgNO_3)_2$, which produces 52% RH. Each calibration point should be approached from a lower humidity to eliminate hysteresis effects. A typical calibration curve will be found in the Appendix.

If the RH sensor cannot be calibrated by following the procedures in this section, the humidity element may require replacement. If the calibration cannot be carried out with a new or recently replaced humidity element, the Factory Checkout Procedure given in the Appendix should be carried out by a qualified instrument technician.

5.2.3 Changing Humidity Elements

In the event a humidity or temperature sensor becomes damaged, the new sensing element can be easily replaced. Remove the protective stainless steel sensor cover by pulling in a smooth twisting motion The humidity sensor leads can then be released by loosening the 4-40 retaining nuts. Use care not to touch the surface of the humidity sensor with the fingers; hold the sensor by the edges.* When replacing sensors, it is desirable to perform the calibration procedure, as all sensors have slight variations in their characteristics.

*Lab gloves recommended

5.3 Meter Face Care

The plastic meter face should be wiped at least once per year with a de-static agent such as a weak household detergent, or one of the commercial preparations available for this purpose. Failure to do this may result in erroneous readings (particularly in very dry regions) as a static charge on the meter face can "pull" the pointer from its true reading.

5.4 Troubleshooting

The most common types of instrument malfunctions are related to low reading, or no reading, offscale reading or erratic readings.

5.4.1 Low or No Readings

The typical sources of low or no readings are a lack of power supply voltage and/or failure of a sensor. Possible causes, common to both RH and Temperature positions of the FUNCTION SWITCH are:

a) Instrument not plugged in, or power not turned on.

b) Power supply defective.

c) Circuit breaker open (Reset on rear panel).

d) Open RH element, or open circuit in cable lead to RH sensor.

e) Shorted temperature sensor (platinum RTD). Instrument will read below -50F (-45.6°C).

5.4.2 Offscale (above 100% RH or +150F)*Readings

This condition may be caused by:

a) Shorted RH sensor (function switch in RH position) or shorted cable leads to element.

b) Open temperature sensor (function switch in TEMP position)or open cable leads to platinum RTD.

5.4.3 Erratic Readings

a) Erratic readings on either the RH or Temperature functions are most likely traceable to faulty or intermittent connections. Check circuit board, switch, cable and connectors for faults.

b) Also check meter for stiction or static buildup on face, particularly in low humidity areas. See Section 5.3.

c) Occasionally, in areas where the Indicator is subject to high vibration levels, the taut band meter movement may vibrate (sympathetically) and cause erroneous readings. This fault can easily be eliminated by placing the instrument on a rubber pad.

---

*66°C

6.0 APPENDIX

6.1 Factory Instrument Checkout Procedure

6.2 Model 400C Electrical Schematic (GE Dwg. 100126)

6.3 Parts List

6.4 Type 011 Vacuum Mount Dimensions (Dwg. 100129)

6.5 Model 411 Sensor Dimensions (Dwg. 100110

6.6 Panel Mounting Template

6.7 Psychrometric Chart

6.8 Calibration Fixture Details

6.9 Typical Model 400C/CD Calibration Chart

6.10 Resistance vs. Temperature Data, Ambient Temperature Sensor

6.11 Supplement, Instructions for Using the Model 400C/CD Indicator with Model 402 Six-Position Selector Unit

6.12 Supplement, Instructions on Using the Model 400C with the Model 700RH, -RH/M Aspirator

6.13 Supplement, Instructions for the Model 450 Relative Humidity and Temperature Transmitter. (Supplied only with sale of Model 450)

6.14 Table I, Recommended Saturated Salt Solutions for Calibrating Series 400 Relative Humidity Instruments

6.1 Factory Checkout Procedure

6.1.1 RH Circuit Alignment Procedure

a) Inspect circuit board, components and connections, mechanically zero meter. Check pot and switch mounting nuts as well as knob set screw for tightness. If the instrument has never been aligned center all pots. Disconnect sensor cable at rear of indicator. Connect jumpers from negative recorder outputs to adjacent ground terminals at rear terminals.

b) Apply 115 VAC power.

c) Turn switch to RH and check power supply-ground at TP-1, +15V ±0.3V at TP-s and -15V, ±0.3V, at TP-3.

d) Observe square wave voltage from ground to TP-4; amplitude 26V, ±4V with a period of 9 ms, ±1 ms.

e) Use a 1% decade resistor to simulate RH sensor at pin A and B of connector and use a 1K ohm, 5% resistor at pins H and J to simulate thermistor temperature compensation.

f) With decade box open (infinite resistance) set LO RH, R25, for reading of 0% RH. (Note any time R23 GAIN is set, R25 must be reset as in this step.)

g) Set decade to 1.2K ohm to simulate 100% RH and set BAL R15 and 30% RH CAL R10 (rear panel to center). Set GAIN R23 for 5.00 ±0.1V out at the 5V rear terminal. The 100% RH CAL R4 (rear panel) can be used for a fine adjustment. Set METER CAL R50 for a reading of 100%. Check voltage at 50 MV terminal for 50 MV out.

h) Short pin 6 of A4 and pin 6 at A5 to ground. Then adjust R23 for 100% reading.

i) Remove shorts and make meter read 100% with BAL R15.

j) With decade box open (infinite resistance)set LO RH , R25, for reading of 0% RH. (Note any time R23 GAIN is set, R25 must be reset as in this step.)

k) With a decade at 1.2K reset 100% CAL for 100% on meter if less than 5% adjustment is needed. If more is needed use R23 GAIN, than repeat steps j and k.

l) With a decade at 140K set 30% RH CAL R10, for reading of 30% on meter, then repeat Step k) and l) until no further adjustment is required.

m) The following points (representing a typical RH sensor)* may now be checked. The readings should be within 3% of the indicated values:

---

*NOTE: These resistance values are nominal; the RH percentage points should concur with the resistances given, within ±3% RH.

100%	1.2K
80%	2.9K
60%	9.04K
40%	44.9K
30%	140K
20%	695K
0%	Open

n) This completes the preliminary RH settings - later the instrument will be set up for a specific humidity element, using known humidity environments.

6.1.2 Temperature Alignment and Test Procedure

a) Connect precision decade resistor, one end to pin E of connector - the other end to pins D and C.

b) Set resistance to 82.01 ohms corresponding to -50°F (-45.6°C) and adjust R42 LO for reading of -50°F (-45.6°C).

c) Set resistance to 125.37 ohms corresponding to +150°F (66°C) and adjust R37 SPAN for reading of 150°F (66°C).

d) Check 5V output terminal at rear chassis for 5V output and 50MV terminal for 50MV output, ±1%. On the digital model, 150°F (66°C) equals +3.75 VDC and +37.5 MVDC, respectively.

e) Set resistance to 93.01 ohms and reset R42 LO for 0°F (-17.8°C).

f) Set resistance to 118.97 ohms and reset R37 SPAN for 120°F (49°C).

g) This completes the temperature test.

6.1.3 Instrument Calibration with a Specific Model 411RH and Temperature Sensor

a) Connect probe to be used with instrument to the instrument. Check readings on RH and Temperature. Check temperature reading against an accurate temperature reference after sensor has reached equilibrium temperature. If reading is more than .5°F (.25°C), off, less than 3°F off, (1.5°C) correct with R42 LO pot. If reading is more than 3°F off (1.5°C), troubleshoot.

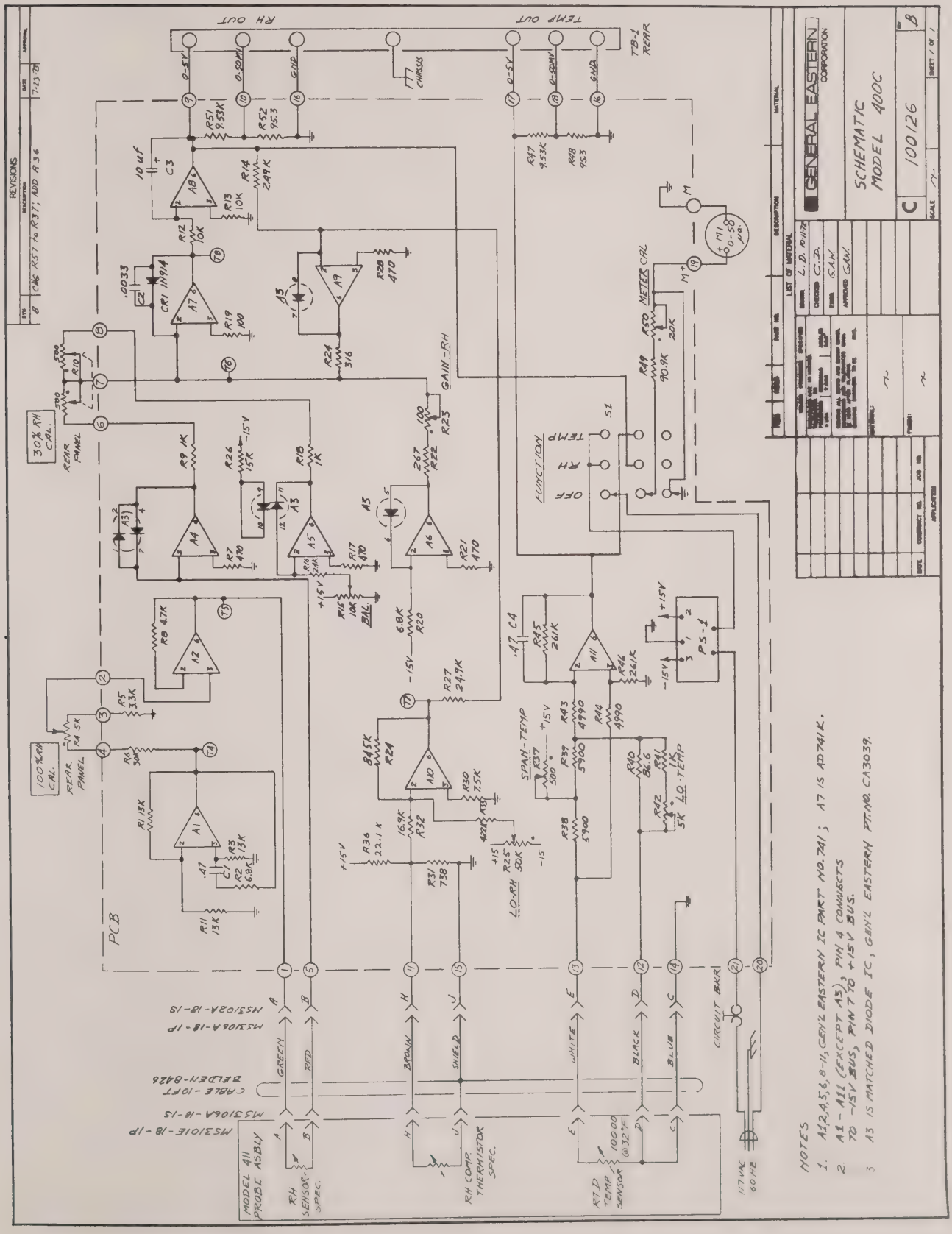
b) Place sensor in a known RH environment between 85% and 96%RH, allow sensor to reach equilibrium (about 90 minutes) and set 100% CAL R4 to make meter read true RH. If setting is beyond range of R4, then center R4 and set R23 GAIN for true RH and make fine adjustment with R4. Then remove nut from one side of RH element on sensor PC Board to open the circuit, and set R25 LO RH for "0" reading. Replace nut. Then again place sensor in environment and reset R4 100% CAL for true RH reading.

c) Place sensor in any RH environment below 25%RH for 90 minutes. Then, place sensor in a known RH environment between 25% and 35% RH and allow sensor to reach equilibrium (about 90 minutes). Then set R10 30% CAL for meter reading of true RH.

d) Repeat Step b) above. If reading is within 3% of true, reset R4 100% CAL and end. If reading is off by more than 3%, complete Step b) and repeat Steps c) and d).

e) This complete the instrument calibration.

6.2 Model 400C Electrical Schematic (GE Dwg. 100126)



6.3 PARTS LIST

Ref. No.	Description
R1	13K 1/4W 5%
R2	6.8K
R3	13K
R4	5K ohm locking pot 10%
R5	3.3 1/4W 5%
R6	30K 1/4W 5%
R7	470 ohm 1/4W 5%
R8	4.7K 1/4W 5%
R9	1K 1/4W 1%
R10	500 ohm Dual Pot 10%
R11	13K 1/4W 5%
R12	10K 1/4W 5%
R13	10K 1/4W 5%
R14	2.49K 1/4W 1%
R15	10K 1/2W Pot 20%
R16	2.4K 1/4W 5%
R17	470ohm 1/4W 5%
R18	1K ohm 1/4W 1%
R19	100 ohm 1/4W 5%
R20	6.8K 1/4W 5%
R21	470 ohm 1/4W 5%
R22	267 ohm 1/4W 1%
R23	100 ohm 1/2W Pot 20%
R24	316 ohm 1/4W 1%
R25	50K ohm 1/2W Pot 20%
R26	15K 1/4W 5%
R27	24.9K 1/4W 1%
R28	470 ohm 1/4W 5%
R29	845K 1/4W 1%
R30	7.5K 1/4W 5%
R31	73.2 ohm 1/4W 5%
R32	16.9K 1/4W 1%
R33	422K 1/4W 1%
R34	10K ohm 1/2W Pot 20%
R36	22.1K 1/4W 1%
R37	500 ohm 1/2W Pot 20%
R38	5.9K 1/4W 1%
R39	5.9K 1/4W 1%
R40	86.6 ohm 1/4W 1%
R41	1000 ohm 1/4W 1%
R42	5K 1/2W Pot 20%
R43	4.99K 1/4W 1%
R44	4.99K 1/4W 1%
R45	261K 1/4W 1%
R46	261K 1/4W 1%

Ref No.	Description
R47	9.53K 1/4W 1%
R48	95.3 ohm 1/4W 1%
R49	90.9K 1/4W 1%
R50	20K 1/2W Pot 20%
R51	9.53K 1/4W 1%
R52	95.3 ohm 1/4W 1%
C1/C4	.47 µf 100V Cap
C2	.0033 µf 100V Cap
C3	10 µf 35V Tant. Cap.
A1	741 Op Amp U5B7741393
A2	"
A4	"
A5	"
A6	"
A7	Op Amp AD741K
A8	Op Amp U5B7741393
A9	"
A10	"
A11	"
A3	Diode Array (Special)
S1	Switch 42P36-03-1-35 Grayhill
CB1	Circuit Breaker 815.650 Littlefuse
PS1	Servotron Corp. EE15D50 Power Supply ±15V 50 ma
J1	MS3102A-18-1S Connector
M1	Meter, analog 0-50 µa

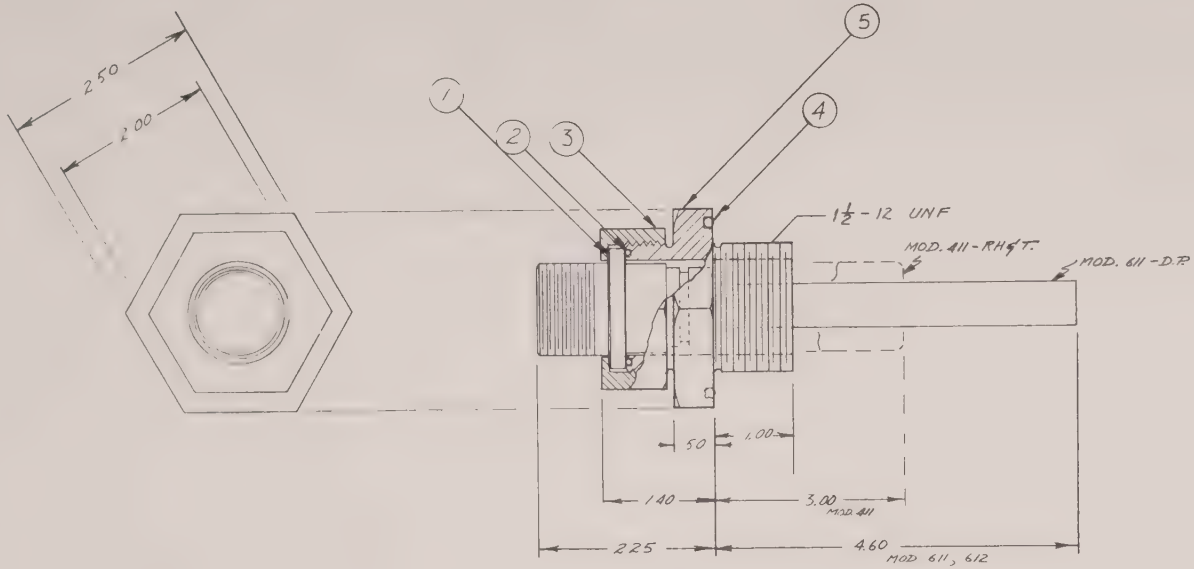
CHANGES IN ABOVE COMPONENTS FOR MODEL 400CD (Digital) in °F

R40	95.3 ohm 1/4W 1%
R45	523K 1/4W 1%
M1	Meter, Digital 199.9 MV
DR1	2K 1/4W 1%

CHANGES IN ABOVE COMPONENTS FOR MODEL 400CD (Digital) in °C

R40	107 ohm 1/4W 1%
R45	280 Kohm 1/4W 1%
M1	Meter, Digital 199.9 MV
DR1	2K 1/4W 1%

REVISIONS			
SYM	DESCRIPTION	DATE	APPROVAL



NOTE: RATED PRESSURE 200 PSIG.

SEE PARTS LIST

ITEM	REQD	PART NO.	DESCRIPTION	MATERIAL
5	1		PRESSURE BOSS	ANOD. ALUM.
4	1		O-RING	BUNA-N
3	1		COLLAR NUT	ANOD. ALUM.
2	1		O-RING	BUNA-N
1	1		WASHER	316 SS

LIST OF MATERIAL

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES.
TOLERANCES ON
FRACTIONS ± 1/64 | DECIMALS .XXX ± .005 | ANGLES ± 0.5°
REMOVE ALL BURRS AND SHARP EDGES. DIMENSIONS AND TOLERANCES SHALL BE HELD AFTER PLATING. MINIMUM RADII TO BE .010

DRAWN RD 4/12/72
CHECKED SRN
ENGR
APPROVED
MATERIAL
FINISH
DATE | CONTRACT NO. | JOB NO.
APPLICATION

GENERAL EASTERN CORPORATION

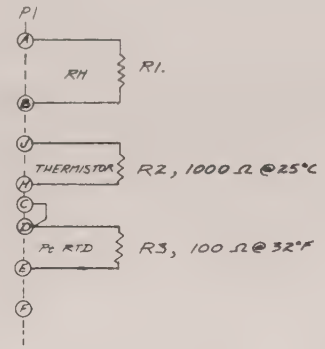
PRESSURE BOSS
TYPE-011

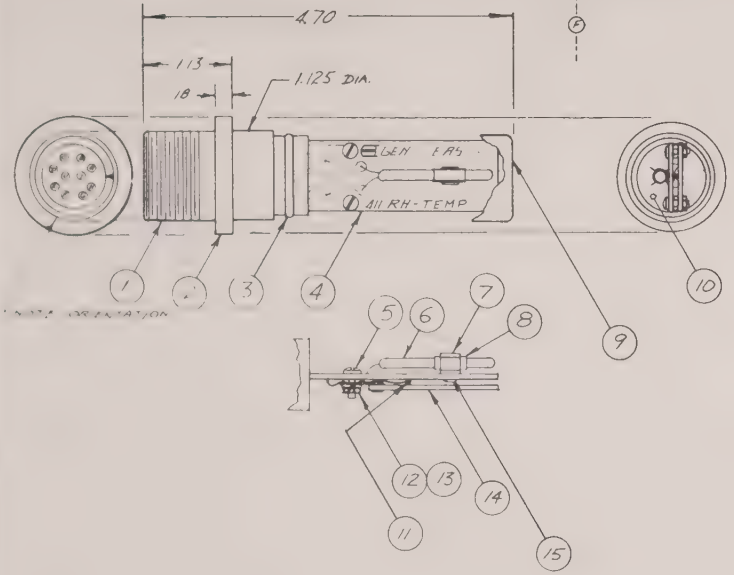
C | 1001.9 | REV A

SCALE FULL | SHEET 1 OF 1

REVISIONS					
ZONE	LTR	E.C.O. No.	DESCRIPTION	DATE	APPROVED
	A		INITIAL RELEASE		

SCHEMATIC





REF DES	QTY REQD	PART OR IDENT NO.	DESCRIPTION	ITEM NO.
	1		RIVET,	15
R1	1	SPEC.	HUMIDITY SENSOR	14
	2		LOCKWASHER, SPLIT, 4-40, S.S.	13
	4		NUT, 4-40 x 1/4 (HEX), S.S.	12
R2	1	YSI 44003	THERMISTOR, COMP. (YSI)	11
	1		POTTING, (ALLACO, 20-20)	10
	1	B100028	SHEATH, PROBE	9
	1		SLEEVE, 3/8 x 1/8 DIA. SHRINKFIT	8
	1	3B652	CLIP, (BIRTCHER)	7
R3	1	W-61	PLATINUM RTD (DE GAUSSA)	6
	2		SCREW, 4-40 x 5/16, B.H., S.S.	5
	1	A-100106	PCB	4
	1	2-118	O-RING, BUNA-N, (PARKER)	3
	1	B100096	MOUNT, PRESS. PROBE	2
P1	1	MS-3101E-18-1P	CONNECTOR (BENDIX CB-3101A-18-1P-002)	1

DWG CLASS

DASH NO. | NEXT ASSY | USED ON

CROSS INDEX | APPLICATION

UNLESS OTHERWISE SPECIFIED
REMOVE ALL BURRS & BREAK SHARP EDGES .005 MAX.
DIMENSIONS ARE IN INCHES TOLERANCE ON
DECIMALS: XX ± .015, XXX ± .005
FRACTIONS ± 1/32
ANGLES ± 1°
SURFACE ROUGHNESS: √ MICRO INCHES
DO NOT SCALE PRINT

MATERIAL: ~

FINISH SPECS: ~

DRAWN	GAW	9-3-72	DATE
CHECKED	RD	9-7-32	DATE
			DATE
			DATE
			DATE

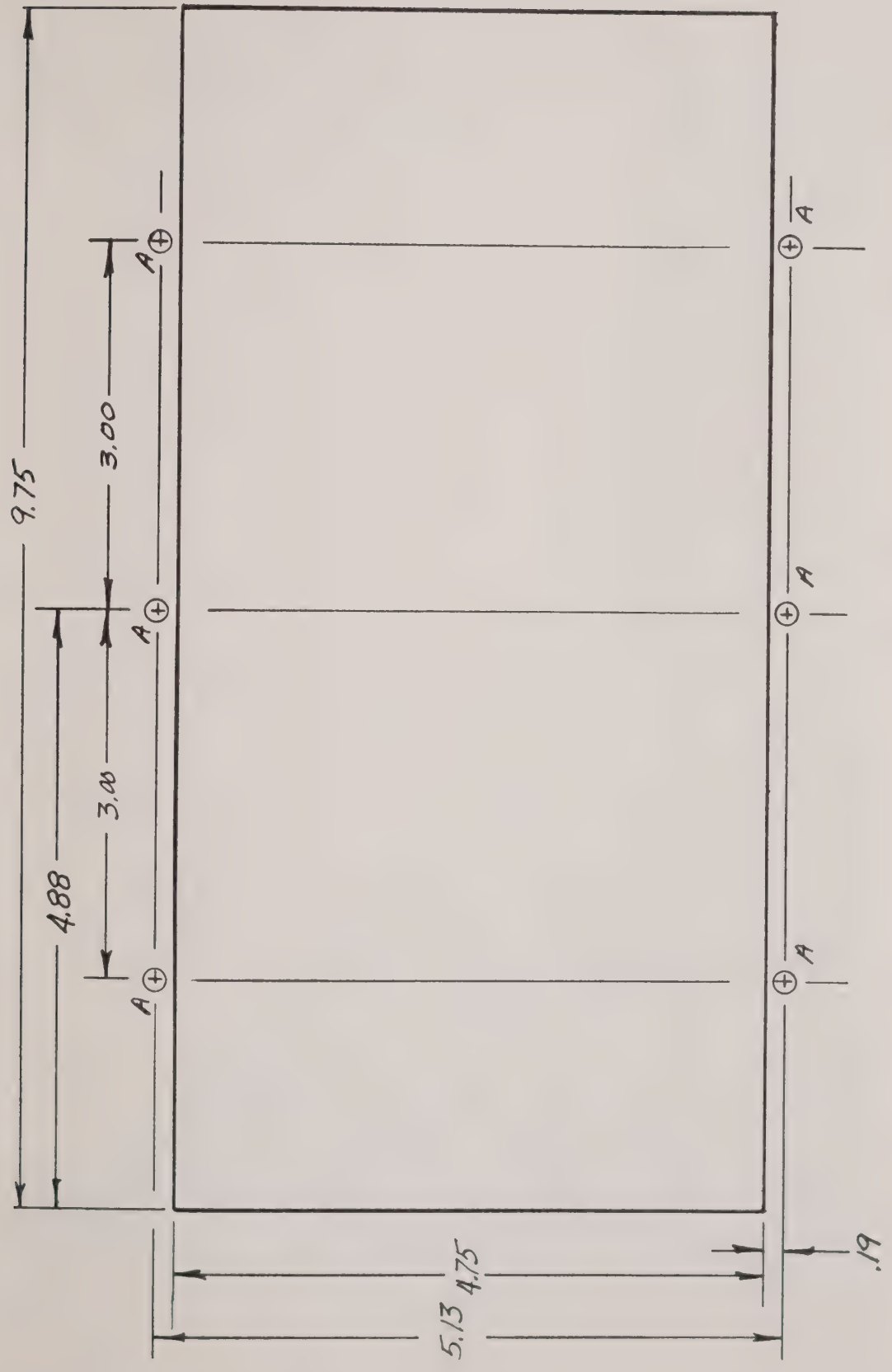
GENERAL EASTERN CORPORATION

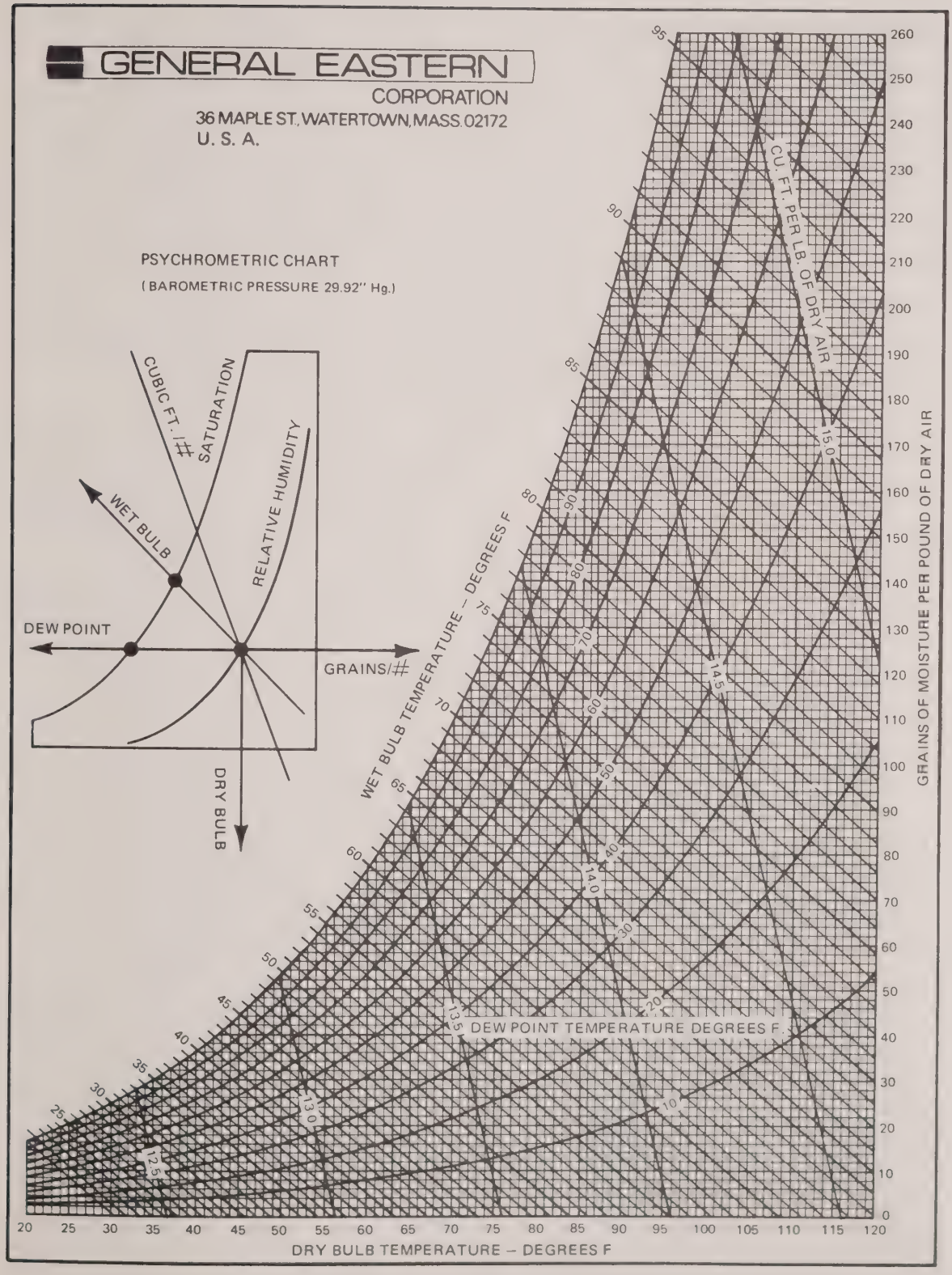
SENSOR ASSEMBLY
MODEL 411 -RH/TEMP SENSOR

SIZE	CODE IDENT NO.	TYPE		REV
C			100110	A

SCALE 1/1 | SHEET 1 of 1

6.6 Panel Mounting Template




GENERAL EASTERN
CORPORATION
36 MAPLE ST. WATERTOWN, MASS. 02172
U. S. A.
PSYCHROMETRIC CHART
(BAROMETRIC PRESSURE 29.92" Hg.)
CUBIC FT. /#
SATURATION
RELATIVE HUMIDITY
WET BULB
DEW POINT
GRAINS/#
DRY BULB
CU. FT. PER LB. OF DRY AIR
WET BULB TEMPERATURE – DEGREES F
DEW POINT TEMPERATURE DEGREES F.
GRAINS OF MOISTURE PER POUND OF DRY AIR
DRY BULB TEMPERATURE – DEGREES F
20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100 105 110 115 120
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250 260
12.5
13.0
13.5
14.0
14.5
15.0

6.8 Calibration Fixture Details

The Model 400C Relative Humidity and Temperature Indicator can be readily checked for overall system accuracy by placing the 411 RH and Temperature Sensor in a known environment. "Known" temperature environments are easily obtained, but known RH environments usually must be generated to effect a calibration procedure.

The use of saturated salt vapor pressure baths for RH calibration work has been standard practice in both the National Bureau of Standards and the U.S. Weather Bureau for many years, and has also been adopted as ASTM-E 104-51. The procedure provides a simple and effective method of calibrating most resistance-type or electrolytic humidity sensors, and is accurate to ±1% RH, if care is taken in using the method.

There are a large number of salts which, when held in a water-saturated condition, will produce a known and constant humidity in a closed container at a given temperature. A group of these salts covering the full humidity range is given in Table I. These salts have been selected on the basis of their commercial availability and their relative freedom from temperature effects.

Calibration of the Model 400C requires two calibration points to be established, one near saturation and one near 30% RH. Potassium sulphate provides an RH of 96.5% RH, and magnesium chloride is used to establish 33% RH at 68°F (20°C). The temperature may vary ±3°F (±1.5°C) from 68°F (20°C) without appreciable effects on the RH.

To establish the known environments, any simple, inert enclosure (preferably glass) which is capable of providing a reasonably airtight seal with the collar of the humidity sensor, can be used. A standard laboratory dessicant jar, with stopper, or a "canning" jar with an adapted cover, work well. The bottom of the jar should be covered with about .12" (.5 cm) of salt, and then a small quantity of distilled water added to produce a slushy mixture. The water must be added a little-at-a-time, as it takes a surprisingly small amount to dissolve all of the crystals. Crystals of the salt must be visible in the slush. Care should be used to prevent the salt mixture from contacting the upper regions of the container and cover, where it could eventually contact the sensor element directly. After the salt solutions are made up, the containers are closed, allowing the new RH to establish.

To perform a calibration, remove the stainless steel cover from the sensor, and place the sensor first into the 96.5% RH container, using care not to contaminate the element. Allow the sensor to equilibrate with the new RH for at least 90 minutes, and then adjust the 100% RH control on the rear of the instrument to produce a reading of 96.5% RH.

Next, place the sensor in a humidity of less than 33% (such as a saturated salt bath of potassium acetate, which produces 20% RH). If the room environment is below 30% - simply allow the sensor to equilibrate with the room RH.

Remove the sensor from the low RH jar and place it in the 33% RH jar, again allowing 90 minutes for equilibration. Adjust the 30% RH Control on the rear of the instrument to provide a meter reading of 33% RH.

NOTES:

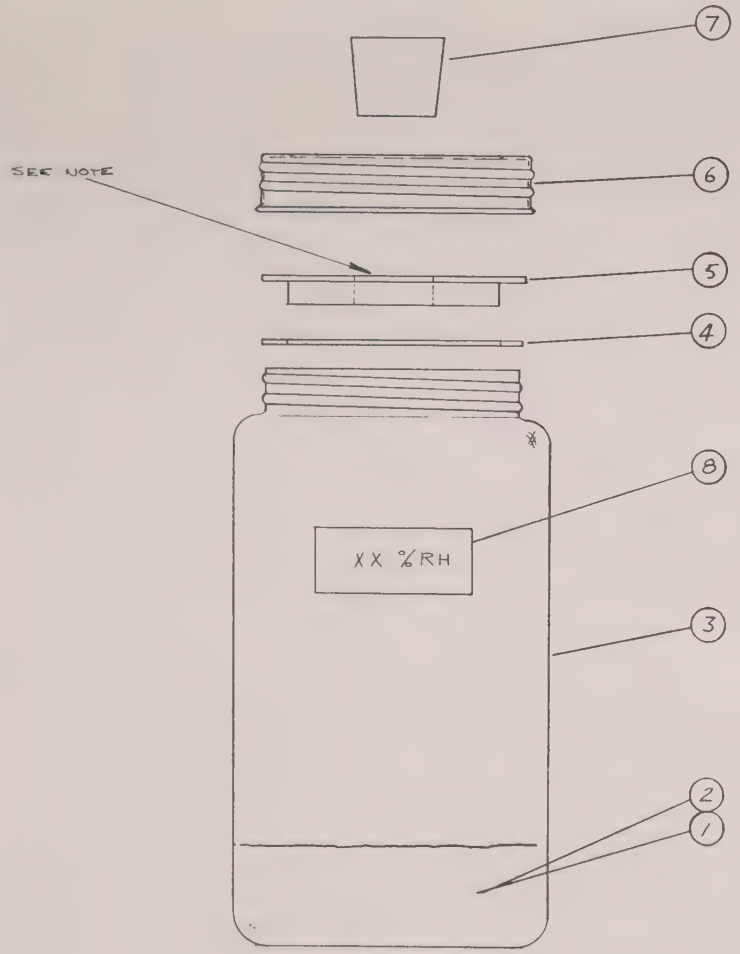
1) If the container can be equipped with a small, slow (so as not to spatter salt solution onto the sensor element) speed fan, equilibration will be reached within five (5) minutes. Small "experimenter or hobby shop" dc motors with miniature plastic fans have been used successfully to enhance equilibration.

2) The instrument may be checked in salt baths at other values of RH, but the calibration controls should not be adjusted at other than at or near 90% (±9%) and 30% (±5%) RH.

3) To eliminate hysteresis errors, each calibration %RH point should be approached from the low side.

A typical Model 400C/CD Calibration Chart is attached.

REVISIONS			
DWG	DESCRIPTION	DATE	APPROVAL



%RH	SALT TYPE	TEMP	
96.5	POTASSIUM SULPHATE K_2SO_4	20C	*
75	SODIUM CHLORIDE NACL	20C	
53	MAGNESIUM NITRATE $Mg(NO_3)_2$	20C	
33	MAGNESIUM CHLORIDE $MgCl_2$	20C	*
11	LITHIUM CHLORIDE LiCl	20C	

NOTE: USE OF LiCl IS VERY DIFFICULT - INSTRUMENT WILL TEND TO READ LOW (ABOUT 8-9% RH)

* REQ'D FOR CALIBRATING MOD. 400C

ITEM	REQD	PART NO.	DESCRIPTION	MATERIAL
8	2		LABEL	
7	2		#8 STOPPER	RUBBER
6	2		SCREW LID	
5	2	A100099-A	INSERT	PVC PLASTIC
4	2	A100100-A	GASKET	NEOPRENE
3	2		1 QT CAN'G JAR	
2	4oz		SALT	SEE TABLE 1
1	4oz		DIST. WATER	

LIST OF MATERIAL

NOTE: FOR USERS DESIRING TO BUILD THIS FIXTURE, HOLE SHOULD BE 1.060 +.005 -.000 DIA.

UNLESS OTHERWISE SPECIFIED
DRAWN T SALEE
CHECKED
ENGR
APPROVED

GENERAL EASTERN CORPORATION

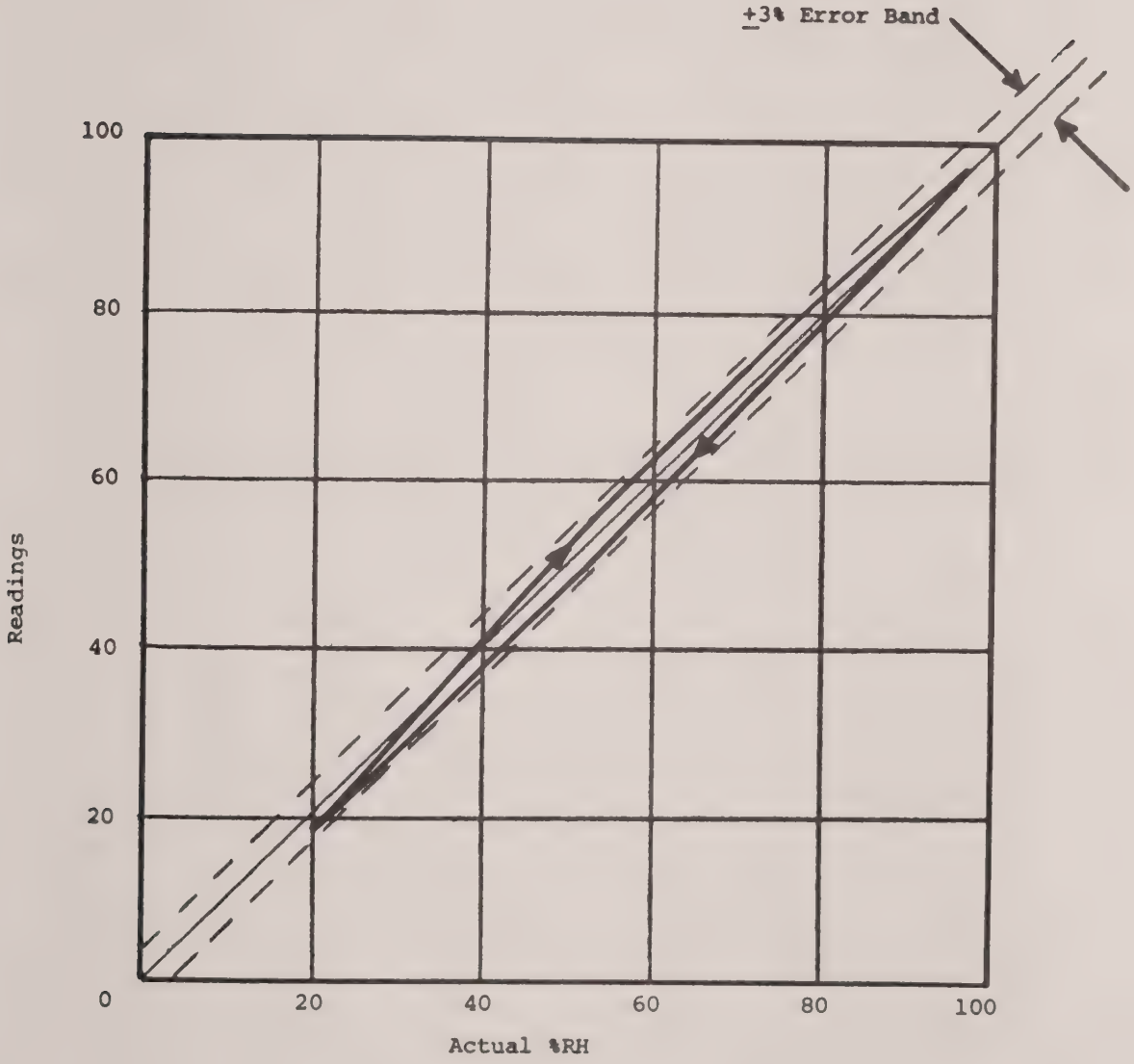
SAT. SALT CALIB KIT
(FOR MODEL 400C)

C 100148 A

SCALE NONE SHEET OF

DATE CONTRACT NO. JOB NO.
APPLICATION

6.9 Typical Model 400C/CD Calibration Chart



TYPICAL CALIBRATION CURVE

Models 400C/CD

6.10 RESISTANCE vs TEMPERATURE DATA

(for Platinum Resistance Thermometers
used in General Eastern instruments)

TEMPERATURE		RESISTANCE	
°C	°F	Ohms	
-45.6°C	-50°F	82.01	
-40.0	-40	84.21	
-34.4	-30	86.41	
-28.9	-20	88.61	
-23.3	-10	90.81	
-17.8	0	93.01	Calibration Point
-12.2	+10	95.20	
-6.67	+20	97.38	
0	+32	100.00	
4.44	+40	101.74	
10.0	+50	103.90	
15.6	+60	106.06	
21.1	+70	108.22	
26.7	+80	110.38	
32.2	+90	112.53	
38.0	+100	114.68	
43.0	+110	116.82	
49.0	+120	118.97	Calibration Point
54.0	+130	121.10	
60.0	+140	123.24	
66.0	+150	125.37	

6.11 USING THE MODEL 400C/CD RELATIVE HUMIDITY AND TEMPERATURE INDICATOR WITH THE MODEL 402 SIX-POSITION SELECTOR UNIT

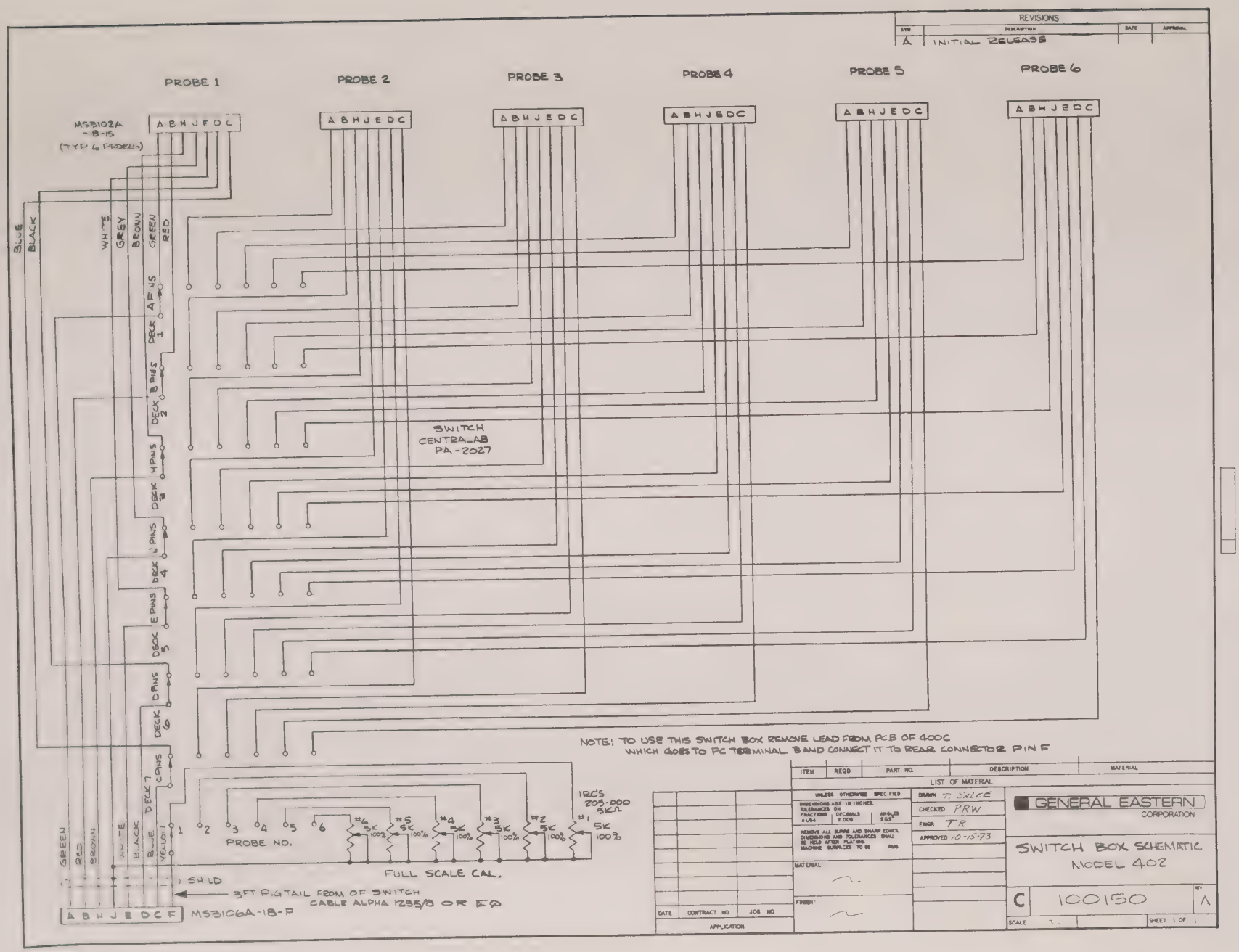
When used with the Model 402 Selector Unit the Model 400C/CD is furnished with a minor modification to permit individual calibration of the humidity elements. This modification is shown on the enclosed schematic, 100150, and consists of the addition of an extra wire to the normally unused pin F on the RH sensor receptacle on the rear of the Indicator, which is then brought to the selector unit via the cable connector. This extra wire is used to connect a separate 100% RH Calibration Pot into the circuit for each sensor, permitting independent high end calibration of each sensor.

The Model 402 is equipped with six, "100%RH Calibration" pots on its rear panel, which are switched into the circuit, as required. (It is not possible to provide individual 30% RH calibration for each sensor due to the complexity of the circuit and switching requirements.) It is therefore important that the serialization of the sensors be maintained if maximum accuracy of the system is to be realized. If sensor locations are varied, recalibration may be required. The sensors are serialized with a 5-digit number in the following manner:

S/N X XXX X

year (74, 75, etc.) — day of year manufactured — Unit (0 for Indicator, 1 for Sensor #1, 2 for Sensor #2, for Sensor #3, etc.)

If recalibration is required, the "100% Cal Adjusts" on the rear of the 402 Unit are used to set the high end of each sensor, as the 100% cal on the rear of the 400C Indicator is inoperative. However, the low end (30% RH) calibration is made at the rear of the 400C, which must be a single, compromise adjustment for six sensors.


REVISIONS
SYM DESCRIPTION DATE APPROVAL
A INITIAL RELEASE
PROBE 1
PROBE 2
PROBE 3
PROBE 4
PROBE 5
PROBE 6
MS3102A -8-1S (TYP 6 PROBES)
A B H J E D C
BLUE
BLACK
WHITE
GREY
BROWN
GREEN
RED
A PNS
DECK 1
B PNS
DECK 2
H PNS
DECK 3
J PNS
DECK 4
E PNS
DECK 5
D PNS
DECK 6
C PNS
DECK 7
SWITCH CENTRALAB PA-2027
NOTE: TO USE THIS SWITCH BOX REMOVE LEAD FROM PCB OF 400C WHICH GOES TO PC TERMINAL B AND CONNECT IT TO REAR CONNECTOR PIN F
IRC'S 203-000 5KΩ
#6 5K 100%
#5 5K 100%
#4 5K 100%
#3 5K 100%
#2 5K 100%
#1 5K 100%
1 2 3 4 5 6
PROBE NO.
FULL SCALE CAL.
GREEN
RED
BROWN
WHITE
BLACK
BLUE
YELLOW
SHLD
3FT PIGTAIL FROM OF SWITCH CABLE ALPHA 1295/8 OR EQ
A B H J E D C F
MS3106A-18-P
ITEM REQD PART NO. DESCRIPTION MATERIAL
LIST OF MATERIAL
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
FRACTIONS ±1/64 DECIMALS ±.005 ANGLES ±0.5°
REMOVE ALL BURRS AND SHARP EDGES. DIMENSIONS AND TOLERANCES SHALL BE HELD AFTER PLATING. MACHINE SURFACES TO BE RMS
MATERIAL
FINISH
DRAWN T. SALEE
CHECKED PRW
ENGR TR
APPROVED 10-15-73
DATE CONTRACT NO. JOB NO.
APPLICATION
GENERAL EASTERN CORPORATION
SWITCH BOX SCHEMATIC
MODEL 402
C 100150 A
SCALE
SHEET 1 OF 1

6.12 SUPPLEMENTARY INSTRUCTIONS - USING THE MODEL 400C WITH THE MODEL 700RH, -RH/M ASPIRATOR; CABLING REQUIREMENTS AND INSTALLATION DETAILS

The Model 700RH is a motor aspirated, thermally-shielded enclosure for the Type 411 Relative Humidity and Temperature Sensor. When provided with the Field Mounting Kit (700 RH/M), it permits meteorological measurements of %RH and Temperature with remote display on the Model 400C Indicator.

Cabling Requirements

The humidity sensitive element employed in the Model 411 sensor is a relatively high impedance device; (typically, 1000 ohms @100% RH, to 10 Megohms @15% RH). Therefore, attention must be given to the type and length of cable employed with the sensor in order to prevent the cable capacity and leakage resistance from influencing the RH measurement. A suitable cable for this application is Alpha Type 8778, wired in strict accordance with General Eastern Corporation Dwg. C100169. Use of other cable types may cause excessive capacity to develop across the humidity element, causing erroneous readings.

Site Selection

The Model 700RH Aspirator Assembly should be located so as to provide a representative sample of the environment to be measured. The ideal meteorological site (as prescribed by the World Meteorological Organization's standards on climatological measurements) would require the aspirator base to be mounted in full solar exposure, six (6) feet above a mowed, grassy surface, away from buildings, vents and similar heat or water vapor sources, which could influence the measurement.

In mounting the aspirator, consideration should also be given to its accessibility for maintenance.

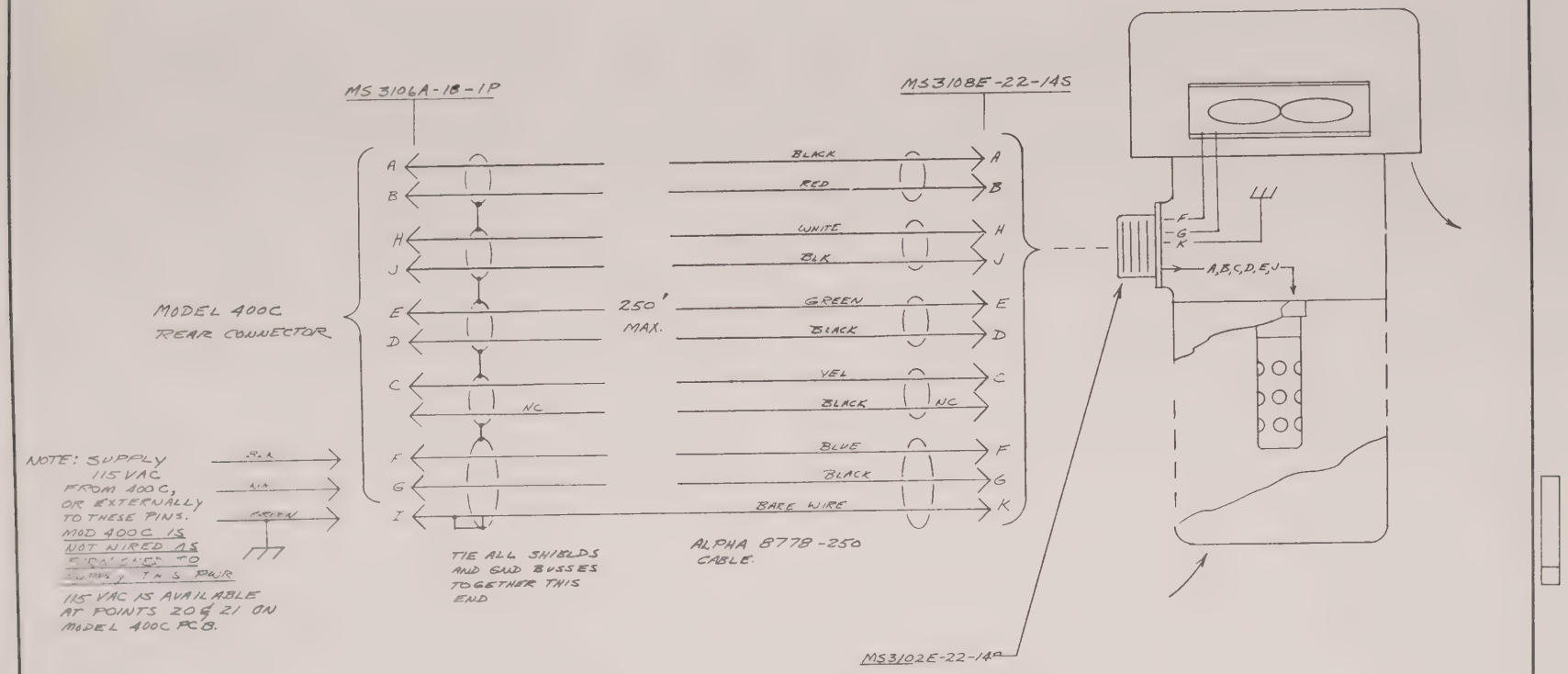
Calibration and Maintenance

Use of the Model 400C Relative Humidity and Temperature Indicator for outdoor (meteorological) measurements is one of the most rigorous applications to which the system can be applied. Contaminants (mainly SO_2 and limestone dust) which accumulate with time, can affect the calibration of the humidity element. Depending on the level of industrialization in the region, the calibration of the system should be checked at least every six months, and more often in heavily air-polluted areas. The RH sensor can be most easily checked by using the saturated salt bath method described in the Factory Checkout Procedure in the Model 400C/CD Instruction Manual (Section 6.1). Any shift in the sensor calibration can usually be corrected with the controls provided for this purpose on the rear panel of the Model 400C Indicator. If the sensor element is beyond the range provided by these controls, it must be replaced.

A very convenient method for calibrating the system at the site (including the cable)is to equip two (2) wide mouth thermos bottles with the slushy salt mixtures (MgCl for 33% RH; K_2SO_4 for 98.6% RH). The corks can be bored to accommodate the sensor diameter, and rubber stoppered when not in use. An extension cable will permit the sensor to be removed from

the aspirator and placed in the appropriate salt bath. Alternatively, the bath can be slipped over the sensor without use of an extension cable, and held in place with a piece of masking tape. Be sure to allow the salt baths to equilibrate indoors to approximately 68°F, ±2°F, (20°C, ±1°C) before using. The same chambers, equipped with glass thermometers (or a thermocouple system), can be used for a one-point temperature check.

REVISIONS			
SYM	DESCRIPTION	DATE	APPROVAL



ITEM	REQD	PART NO.	DESCRIPTION	MATERIAL
			LIST OF MATERIAL	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES.
TOLERANCES ON
FRACTIONS ± 1/64 | DECIMALS ± .005 | ANGLES ± 0.5°
REMOVE ALL BURRS AND SHARP EDGES.
DIMENSIONS AND TOLERANCES SHALL BE HELD AFTER PLATING.
MACHINE SURFACES TO BE 125 RMS.

MATERIAL:
FINISH:

DRAWN T. SALEE
CHECKED R. Kinslow
ENGR
APPROVED 10-15-73

DATE | CONTRACT NO. | JOB NO.
APPLICATION

GENERAL EASTERN
CORPORATION

700RH/REMOTE
CABLING REQT

C | 100169 | REV A

SCALE | SHEET OF

6.14

TABLE I

RECOMMENDED SATURATED SALT SOLUTION

for

CALIBRATING SERIES 400 RELATIVE HUMIDITY INSTRUMENTS

Salt Solution	Composition	%RH	Temperature °C	Temperature °F
Potassium Acetate	CH_3COOK	20%	20°C	68°F
Magnesium Chloride	$MgCl_2$	33%	20°C	68°F
		32%	30°C	86°F
		32%	40°C	104°F
Magnesium Nitrate	$Mg(NO_3)_2$	53%	20°C	68°F
Sodium Chloride	NaCl	76%	20°C	68°F
		75%	30°F	86°F
		75%	40°C	104°F
Potassium Sulphate	K2SO4	96.5%	20°C	68°F
		96.5%	30°C	86°F
		96.5%	40°C	104°F

NOTE:

1) Minimum required is $MgCl_2$ for 30% CAL point and K_2SO_4 for 100% CAL point.

2) For a more complete list of saturated salt solutions see chemical handbooks